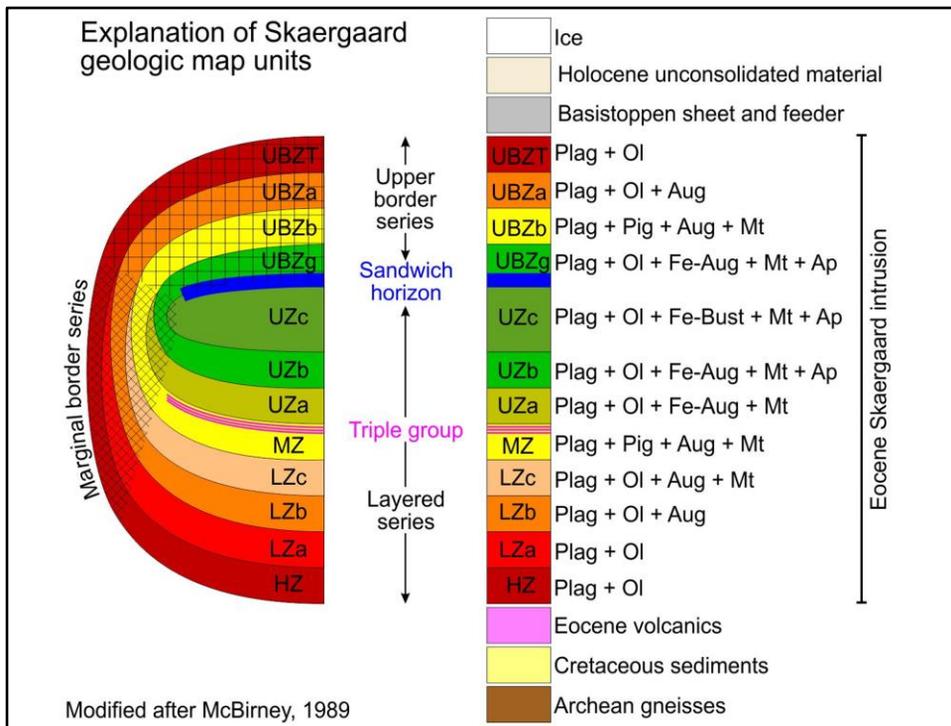


The Skaergaard complex is an Eocene pluton that was emplaced between Archean gneisses below and Cretaceous sedimentary and Eocene volcanic rocks above. The pluton has a volume of about 250 km<sup>3</sup>, and was probably emplaced as a single magma batch into a fault-bounded space above a foundered block (basically the magma was transferred from deeper reservoirs to the space above the foundered stope block). The pluton is tilted downward toward the southeast, so the pluton floor is most closely exposed to the northwest, and the roof (Upper Border Series) is best preserved to the southeast. Surrounding the pluton are steep wall rocks (Marginal Border Series). From bottom to the contact with the Upper Border Series is the Layered Series, which evolves from relatively Mg-rich troctolitic cumulates to ferrogabbros.



This cartoon illustrates the approximate internal stratigraphy of the pluton, the host rocks and other units in the geologic map, and the schematic locations of the border series, platinum-gold-bearing triple group, and the sandwich horizon where the Upper Border Series and the Layered Series met at the finish of crystallization.



Our vessel was the Grigoriy Mikheev, a 2000 ton, ice-hardened, Finnish-built, Russian-crewed, Dutch-operated ship. It was originally built for research, but was leased to Oceanwide Expeditions after budget cuts that followed breakup of the Soviet Union. This shows the crane used to lower the Zodiacs into the water, loading up for the morning trip to see the rocks.



Off to see the rocks. Ship and outlet glacier in the background.



A particularly blue iceberg.



Landing on the shore.



On shore, showing C. Kent Brooks, one of the field trip leaders. He also carried the rifle, for use in case of polar bears (one of which was seen at close range by some of the ship's crew).



View from the highlands, with the ship in the midground.



Central highlands in the Skaergaard. The rocks are very rusty because of weathering olivine and other Fe-bearing minerals.



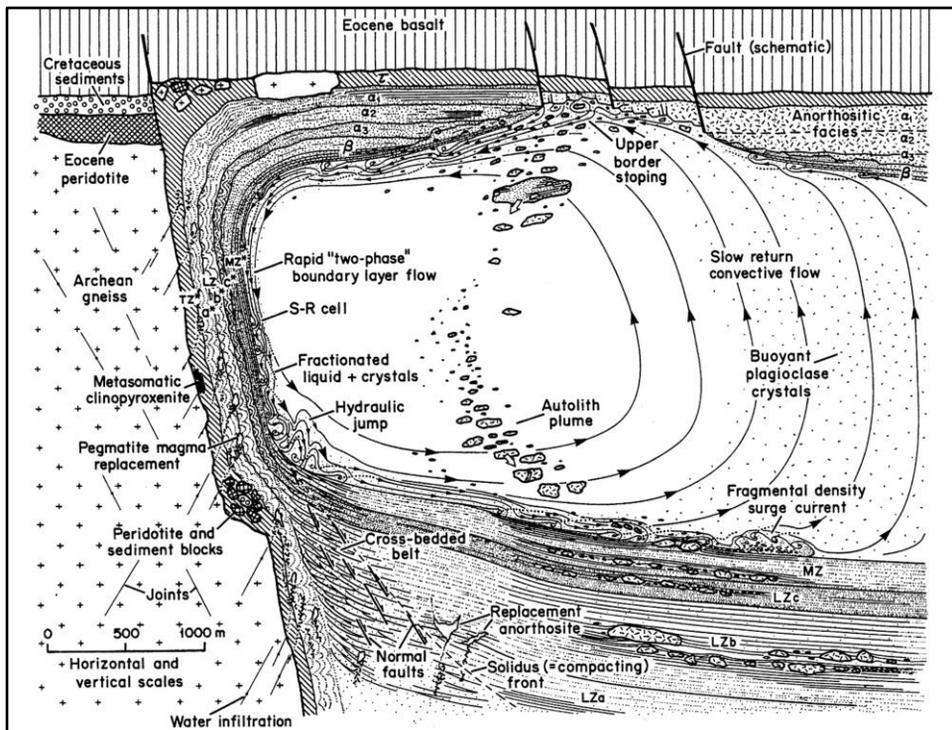
Looking south across one of the fjords from the northwest part of the pluton, showing the steep contact of the pluton (left) with Archean gneisses (right).



Typical gabbro in the Skaergaard.



Lower contact of the pluton against contact metamorphosed Cretaceous sediments, now a mixture of quartz, spinel, and other anhydrous minerals.



Concept of circulation and deposition within the Skaergaard (Irvine et al, 1998). This shows formation of the layered series (floor) marginal border series (wall), and upper border series (roof), with roof failure and sinking of xenolith and autolith blocks. Deposition is associated with turbulent eddies on all pluton interior surfaces.



Thin modally layered beds amongst homogeneous cumulate gabbro. The modally graded layers are rich in mafic minerals at their bottoms, and plagioclase at their tops.



Rhythmic layers, closely spaced.



Thicker modally graded layers, irregularly spaced.



Trough structure, made of modally graded and homogeneous layers, probably representing the locations of swift channel currents.



Another example of one of the channels. Dark layers are particularly rich in magnetite.



“Coliform” layering common on the nearly vertical marginal border series. Center of the pluton is to the right. The cusped forms are probably related to peculiarities of organized turbulence in downward-flowing boundary currents.



Transition between the steeply dipping marginal border series (right) and the less-steeply dipping layered series (left).



Crossbedded belt in the northwest part of the pluton on the Uttantal Plateau. The rocks are mostly troctolites.



Peculiar anorthosite dendrites that formed parallel to the layering in the layered series, presumably resulting from layer-parallel liquid flow.



Replacement anorthosite body, on the Uttental Plateau. These bodies result from the dissolution and replacement of the original rock by migrating hydrous magmatic liquid. They typically have olivine-rich rinds and are commonly associated with mafic pegmatites.



Closeup of replacement anorthosite, which has the texture of an anorthosite adcumulate with augite oikocrysts.



Layered mafic pegmatite, probably associated with hydrous melts injecting between or filling separation zones in the gabbro.



Granophyre (graphically intergrown quartz-alkali feldspar granitic residual liquid) filling a narrow dike. Contains distinct coarse pegmatitic plagioclase, olivine, pyroxene, and magnetite.



Felsic dike cutting the pluton. Dikes like this have isotope ratios indicating they are partial melts from the underlying Archean gneisses.



Basaltic dike crosscutting the landscape. Thousands of such dikes cut the Skaergaard pluton.



Base of the Basistoppen sheet, exposed on the Basis glacier valley wall. The Skaergaard rock is the dark material in the center just above the ice, with the layered Basistoppen sheet above.



Autolith block, with gabbroic layers draped above it.



Autolith blocks strewn across and within modally graded layered series beds.



Large, light-colored autolith block showing the compressed layers beneath the block.



Autolith block in the midground, with cumulates turbulently squished out along a bedding plane from the block impact.



Deformed layers from the impact of an autolith block exposed to the far field.



Zoned dikes cutting through an autolith block. The dikes must have been emplaced while the block was still on the pluton roof, because they are truncated at the top and bottom of the block.



Closeup of the zoned dike in the autolith block in the previous photo.



Olivine basalt xenolith block, showing the fine-grained, rusty-weathering of the block compared to the host gabbro.



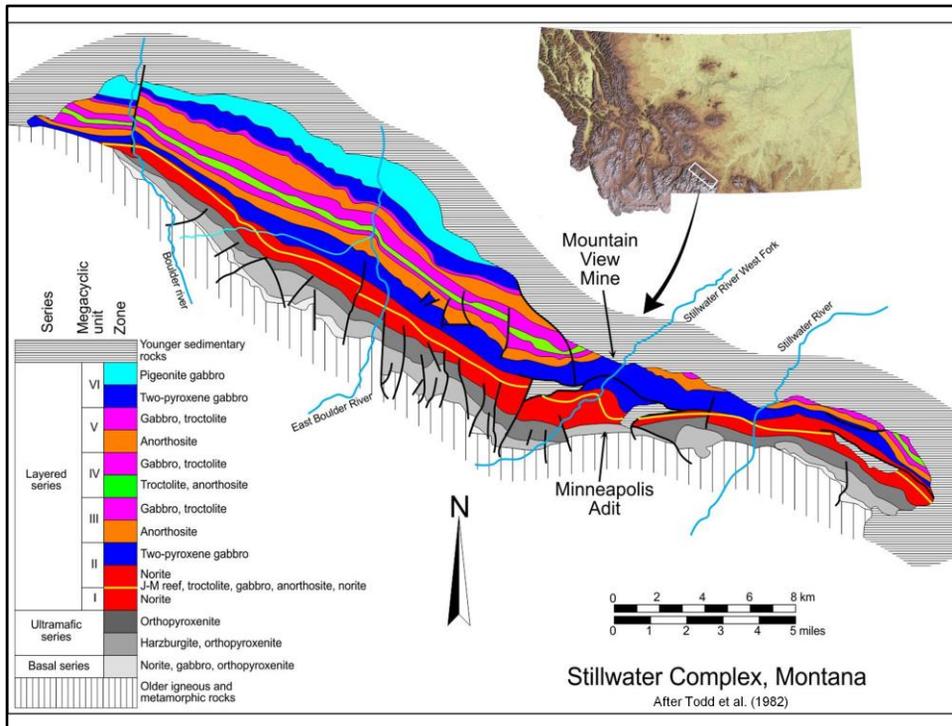
Olivine crystals weathering out from the surface of a basaltic xenolith block.



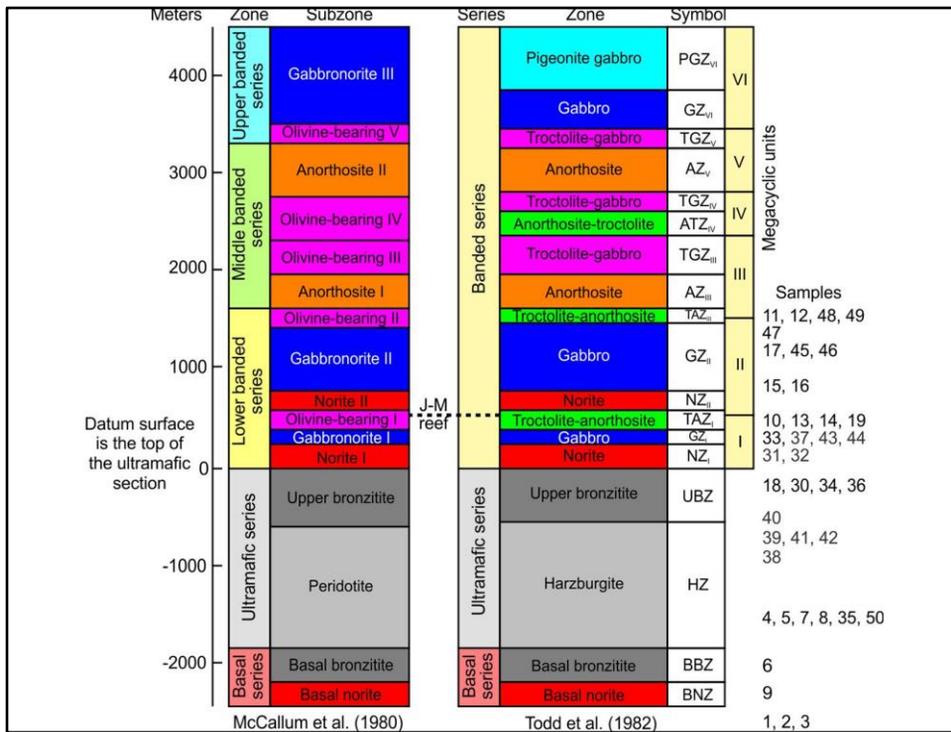
Websterite xenoliths on the northwest side of the Skaergaard pluton.



Xenolith block of Cretaceous sediments. The orange and green spots are spinels.



Map of the Stillwater complex, northeastern Beartooth Mountains, Montana. This is a fragment of an originally much larger Late Archean intrusive body. Now, only the floor and part of the middle cumulate series are exposed. The rest is cut off by faults or covered with younger sediments. The rocks dip steeply to the northeast. This pluton has two economically viable (or almost viable) resources: chromite in the Ultramafic Series, and platinum group elements in the J-M reef in the lower part of the layered series. Copper and nickel might also be economically viable at some point.



Two stratigraphic columns for the Stillwater, from two different papers. I suspect it is not the rocks that are different in the two, but how they are divided into into named units. The samples for this lab are shown to the right.



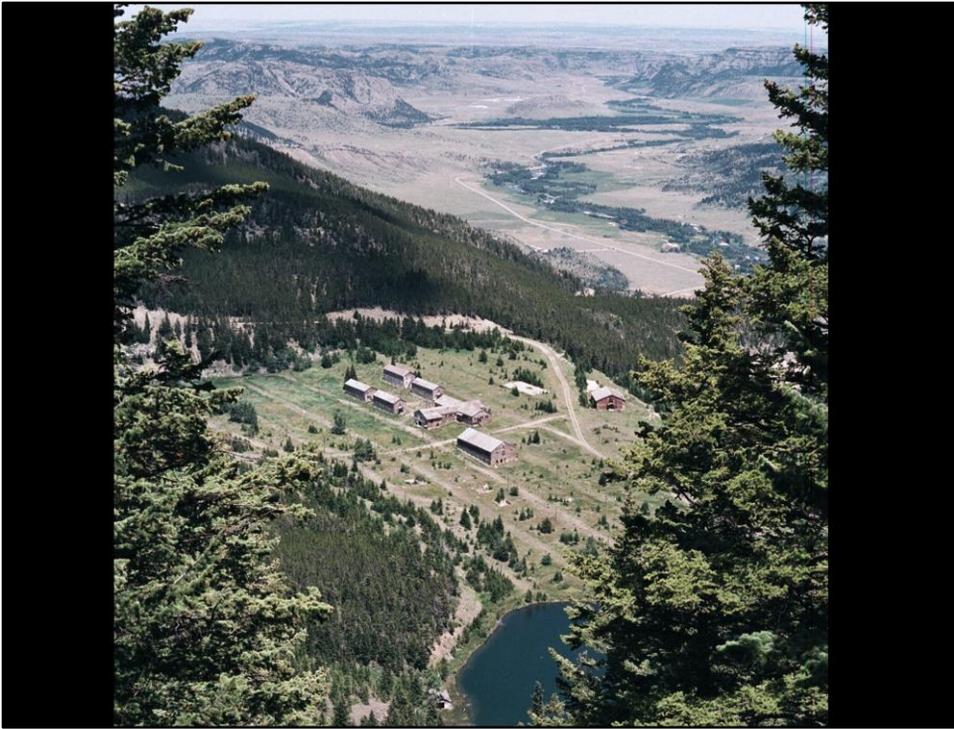
Mountain View Mine, showing the historic miner housing.



Tailings pond for the modern mining operation.



Tailings from the older chromite mine, no longer in operation.



View of the Mountain View mine camp, from the southeast.



Chromite layers in the ultramafic zone.



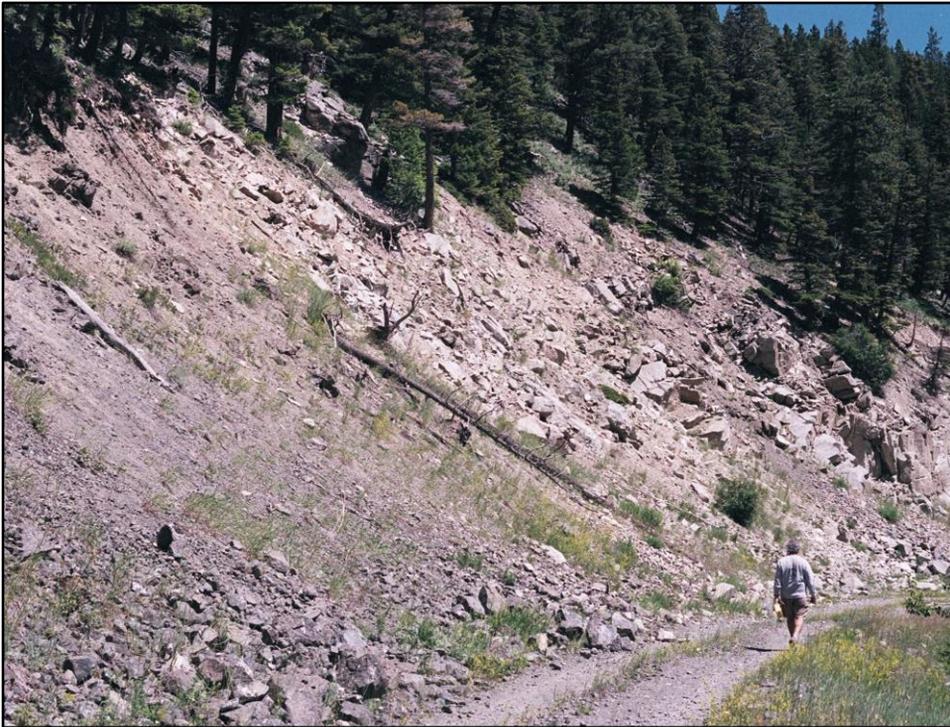
Closeup of some chromite layers. The underside of the upper layer has a cusped surface.



Weakly layered cumulate orthopyroxenite.



Closeup of cumulate orthopyroxenite, with interstitial plagioclase and a clinopyroxene oikocryst in the center.



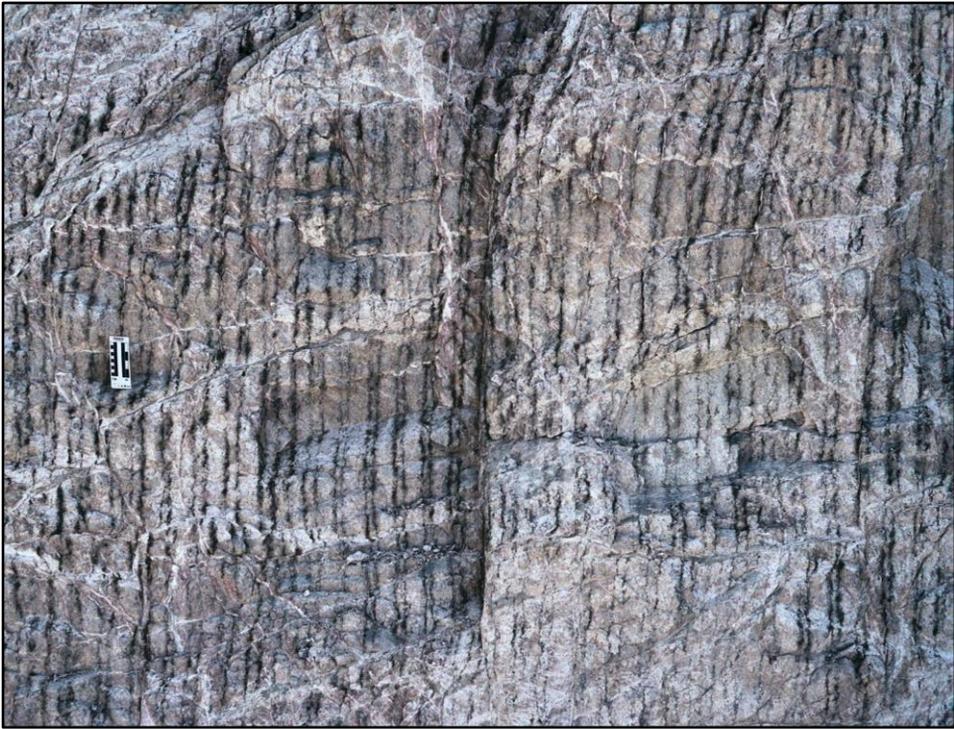
Contact between the dark-colored ultramafic zone to the left, and the lighter-colored layered series to the upper right.



Anorthosite, norite, and an olivine-bearing layer in the middle.



Contact between an olivine-bearing layer (right) and an anorthosite layer (right).



“Inch-scale” layering in a gabbroic anorthosite unit.



Closeup of the inch-scale layering anorthosite unit. Dark mineral is clinopyroxene.